OBSERVATIONAL STUDY

Negative Pressure Wound Therapy in Infected Wounds – Indian Public Hospital Observational Study

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ABSTRACT

Introduction: Negative pressure wound therapy (NPWT) is a procedure in which vacuum is used to enhance wound healing. Vacuum-assisted closure (VAC) refers to wound dressing that uses pressure below normal continuously or intermittently to the surface of a wound. The negative pressure is maintained by an apparatus; this promotes healing in various kinds of wounds and also helps in wound debridement. **Aims:** This study was carried out with an aim to find out the rate of wound contraction, compare infection clearance, granulation tissue formation and to study postoperative pain after using NPWT. **Material and methods:** All types of infected wounds with slough were selected. Patients irrespective of sex between 18 and 70 years of age were included. The wounds included were traumatic, diabetic foot, varicose ulcer, infected wounds, carbuncle, etc. The procedure included surgical debridement as a preliminary procedure, followed by application of NPWT. The wound criteria: 1) size, 2) shape, 3) wound margin and floor, 4) edge and contraction were studied. **Results and Discussion:** Infected wounds can be treated by specific modalities like daily wound dressing, surgical debridement, hyperbaric oxygen therapy and NPWT. NPWT seems more efficient than standard wound care for infected wounds. In our study, the mean size of ulcer in diabetic patients before NPWT was found to be 6.33 × 4.52 cm; after application of NPWT, it was 4.7 × 2.95 cm. The mean size of ulcer in traumatic patients before NPWT was found to be 7.1 × 5.1 cm, while after application of NPWT, it was 5 × 3.63 cm. The mean size of ulcer in vascular patients was found to be 5.71 × 3.85 cm before NPWT, and after application of NPWT, it was 4 × 2.42 cm. NPWT dressings have been proven to be beneficial as a variant method of dressing, mainly by negative pressure which sucks out serous fluid and helps in the formation of granulation tissue. Used in various wounds, continuous suction over period of time and later intermittent suction depending on wound status enhance wound healing process and lead to faster recovery compared to conventional methods of dressing. **Conclusion:** The wound healing period for large traumatic wounds and chronic diabetic wounds is 123 days as per published data. In our study, where NPWT was used, the average wound healing period was 35 days, ranging between 10 and 62, which is statistically significant ($p < 0.005$). NPWT is cost-effective, reduces hospital stay of patient with minimal chances of limb amputation with better results than standard wound care.

Keywords: Vacuum-assisted closure, hyperbaric oxygen therapy, negative pressure wound therapy

Negative pressure wound therapy (NPWT) is a relatively novel method used for managing wounds, both acute and chronic[1]. Vacuum-assisted closure (VAC), or NPWT, uses vacuum to improve wound healing. VAC involves wound dressing that applies pressure below normal, continuously or intermittently, to the surface of a wound[2-4]. The negative pressure promotes healing in different types of wounds[5-7]. It also assists with wound debridement. Wound healing is best at negative pressure of 85-125 mmHg. Application of negative pressure removes fluid, decreases edema and enhances blood flow, and decreases bacterial counts. It is less costly than traditional management of infected wounds[8-13].

A negative pressure of 50-125 mmHg lowers the interstitial pressure, and fluid and debris from the wound gets sucked into a collection chamber[14-18]. In the beginning, the vacuum is continuous, but as the drainage is reduced, the vacuum is applied intermittently. The vacuum dressing is usually changed at approximately 2- to 6-day interval[19-25].

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AIMS AND OBJECTIVES

This study was carried out with an aim to find out rate of wound contraction, compare infection clearance, granulation tissue formation and to study postoperative pain after using NPWT. The study also aimed to determine the length of hospital stay and to evaluate the cost-effectiveness of the procedure and effect on amputation prevention.

MATERIAL AND METHODS

Source of Data

- Patients of Grant Government Medical College and JJ Hospital, Mumbai, Maharashtra.
- A total of 50 cases clinically presenting as ulcer between June 2017 and December 2019 were included in the study.

Inclusion Criteria

- Both male and female.
- Patients between 18 years and 70 years.
- Patients who signed informed written valid consent to be included in the study.
- Patients having acute or chronic wounds, including traumatic wounds, varicose ulcer, bed sore, diabetic wounds.

Exclusion Criteria

- Age less than 18 or above 70 years.
- Patients on chemotherapy or suffering from malignancy.
- Suspected poor compliance.
- If the patient did not sign the consent form.
- Peripheral vascular disease wound with acute or chronic osteomyelitis.

Procedure

Preparation of the wound

After cleaning the wound, foam dressing was cut to shape and kept into the wound cavity. The wound was then sealed with an adhesive dressing ensuring that the drapes covered the foam and tubing and 3 cm of healthy skin.

Negative pressure application

Negative pressure was applied to the wound using vacuum pump (Fig. 1), which delivered continuous or intermittent pressures, ranging from 50 to 125 mmHg. The foam dressing squeezed to the negative pressure. The pressure was applied continuously for the first 48 hours and then changed.

RESULTS AND DISCUSSION

The study was done on 50 patients in Dept. of Surgery, JJ Hospital Mumbai, Maharashtra.

In our study, as shown in Table 1, the mean size of ulcer in diabetic patients before VAC was found to be 6.33 × 4.52 cm, while after the application of VAC, it appeared to be 4.75 × 2.9 cm; the mean size of ulcer in traumatic patients before VAC was found to be 7.1 × 5.1 cm, and after application of VAC, it appeared to be 5 × 3.63 cm; the mean size of ulcer in vascular patients was found to be 5.71 × 3.85 cm before VAC, and after application of VAC, it appeared to be 4 × 2.42 cm. The p value was <0.05 and it was statistically significant. Figure 2 shows diabetic foot infection and Figure 3 depicts necrotizing fasciitis before and after treatment.

VAC therapy is an alternative to routine wound management.

In our study, average age of wounds was 35 days. In a study by Caniano et al[26], average age of wounds was



Figure 1. VAC instrument.

Table 1. Mean Ulcer Size (cm) Before and After VAC Therapy in Wounds of Different Etiology

Etiology	Before VAC		After VAC	
	Length (cm)	Breadth (cm)	Length (cm)	Breadth (cm)
Diabetic	6.33	4.52	4.75	2.95
Traumatic	7.1	5.1	5	3.63
Vascular	5.71	3.85	4	2.42



Figure 2. Diabetic foot infection (biofilm).



Figure 3. Necrotizing fasciitis.

37 days and in that by Ulusal et al[27], it was 32 days, as compared to 59 days with standard dressing. In our study, the mean duration of wound healing was found to be 35.2 days with standard deviation (SD) of 12.03 days. In a study by Zimny et al[28], the mean duration of wound healing was found to be 123.4 days with SD of 10.5 days. On statistical analysis, the p value was calculated to be <0.00001, which is statistically significant with 95% confidence interval (CI).

The wound healing period for large traumatic wounds and chronic diabetic wounds is 123 days as per published data[28]. In our study, where NPWT was used, the average wound healing period was 35 days.

Many mechanisms are suggested. VAC works by increasing the local blood flow and diminishes the edema fluid and colonization rates. The procedure promotes wound closure as it accelerates the formation of granulation tissue and also via mechanical effects on the wound[29]. It provides a clean moist wound and removes excess wound fluid, thus giving way to an ideal wound healing environment.

In our study, out of 50 patients, 36 patients had wound over foot region, 12 patients had wound over back region.

NPWT provides a moist wound environment, favoring granulation of edge of ulcer. A moist wound bed promotes re-epithelialization, action of growth factors, angiogenesis.

A moist wound environment also limits local pain, protecting the nerve endings and enhancing quality of life. Decrease in edema limits interstitial pressure and has a positive impact on microvascular occlusion and lymphatic drainage, thus enhancing the availability of nutrients, oxygen and antibiotics in the wound area[30].

CONCLUSION

From our study, it can be concluded that NPWT is useful in wound healing in various types of wounds; therefore, NPWT should be the modality of choice in management of infected wounds. Vacuum-assisted dressing is more effective than traditional wound dressing. NPWT, in combination with surgical debridement and antibiotic therapy, is effective in managing infected wounds.

The wound healing period for large traumatic wounds and chronic diabetic wounds is 123 days as per published data. In our study, where NPWT was used, the average wound healing period was 35 days, ranging between 10 and 62 days, which was statistically significant ($p < 0.005$).

NPWT is cost-effective, reduces hospital stay of patient with minimal chances of limb amputation with better results than standard wound care.

REFERENCES

1. Eginton MT, Brown KR, Seabrook GR, Towne JB, Cambria RA. A prospective randomized evaluation of negative-pressure wound dressings for diabetic foot wounds. Ann Vasc Surg. 2003;17(6):645-9.
2. Banwell PE, Teot L. Topical negative pressure (TNP): the evolution of a novel wound therapy. J Wound Care. 2003;12(1):22-8.
3. Morykwas MJ, Argenta LC, Sabiston Textbook of Surgery: The Biological Basis of Modern Surgical Practice. First South-East Asia Edition, Philadelphia, PA: Elsevier Saunders; 2012. p. 152.
4. Sabiston DC, Townsend CM. Sabiston Textbook of Surgery: The Biological Basis of Modern Surgical Practice. First South-East Asia Edition, Philadelphia, PA: Elsevier Saunders; 2012. p. 152.
5. Schwartz SI, Brunicardi FC. Schwartz's Principles of Surgery: Self-assessment and Board Review. 10th Edition, New York, London; 2009. p. 266.
6. Greenfield LJ, Mulholland MW. Surgery: Scientific Principles and Practice. 6th Edition, Philadelphia: Lippincott Williams & Wilkins; 2001. p. 3211.
7. Armstrong DG, Lavery LA; Diabetic Foot Study Consortium. Negative pressure wound therapy after partial diabetic foot amputation: a multicentre, randomised controlled trial. Lancet. 2005;366(9498):1704-10.
8. Lazarus GS, Cooper DM, Knighton DR, Percoraro RE, Rodeheaver G, Robson MC. Definitions and guidelines for assessment of wounds and evaluation of healing. Wound Repair Regen. 1994;2(3):165-70.
9. Joseph E. A prospective randomized trial of vacuum-assisted closure versus standard therapy of chronic nonhealing wounds. Wounds. 2000;12:60-7.
10. Lionelli GT, Lawrence WT. Wound dressings. Surg Clin North Am. 2003;83(3):617-38.
11. Bowler PG. Wound pathophysiology, infection and therapeutic options. Ann Med. 2002;34(6):419-27.
12. Williams NS, Bullstrode CJK, O'Connell PR. Bailey & Love's Short Practice of Surgery, 25th edn. Ann R Coll Surg Engl. 2010;92(2):178.
13. Webb LX, Schmidt U. Wound management with vacuum therapy. Unfallchirurg. 2001;104(10):918-26.
14. Lee HJ, Kim JW, Oh CW, Min WK, Shon OJ, Oh JK, et al. Negative pressure wound therapy for soft tissue injuries around the foot and ankle. J Orthop Surg Res. 2009;4:14.
15. Gammal S, Popp R, Schäfer M, el Gammal C, Altmeyer P. A color CD-ROM image analysis system to quantify débridement and healing of ulcers. In: Abatangelo G, Donati L, Vanscheidt W (Eds.). Proteolysis in Wound Repair. Berlin, Heidelberg: Springer Berlin Heidelberg; 1996. pp. 71-86.
16. Cohen IK. An overview of wound healing biology. In: Ziegler TR, Pierce GF, Herndon DN (Eds.). Growth Factors and Wound Healing: Basic Science and Potential Clinical Applications. New York, NY: Springer; 1997. pp. 3-7.
17. Jones SM, Banwell PE, Shakespeare PG. Advances in wound healing: topical negative pressure therapy. Postgrad Med J. 2005;81(956):353-7.
18. Erba P, Ogawa R, Ackermann M, Adini A, Miele LF, Dastouri P, et al. Angiogenesis in wounds treated by microdeformational wound therapy. Ann Surg. 2011;253(2):402-9.
19. Sato K, Yokota T, Ichioka S, Shibata M, Takeda S. Vasodilation of intramuscular arterioles under shear stress in dystrophin-deficient skeletal muscle is impaired through decreased nNOS expression. Acta Myol. 2008; 27(1):30-6.
20. Roseborough IE, Grevious MA, Lee RC. Prevention and treatment of excessive dermal scarring. J Natl Med Assoc. 2004;96(1):108-16.
21. Ryan TJ. Cellular responses to tissue distortion. In: Bader DL (Ed.). Pressure Sores - Clinical Practice and Scientific Approach. London: Macmillan Education UK; 1990. pp. 141-52.
22. Hasegawa S, Sato S, Saito S, Suzuki Y, Brunette DM. Mechanical stretching increases the number of cultured bone cells synthesizing DNA and alters their pattern of protein synthesis. Calcif Tissue Int. 1985;37(4): 431-6.
23. Fabian TS, Kaufman HJ, Lett ED, Thomas JB, Rawl DK, Lewis PL, et al. The evaluation of subatmospheric pressure and hyperbaric oxygen in ischemic full-thickness wound healing. Am Surg. 2000;66(12):1136-43.
24. Joseph E, Hamori CA, Sb B, Roaf E, Swann N, Anastasi G. A prospective randomized trial of vacuum-assisted closure versus standard therapy of chronic nonhealing wounds. Wounds. 2000;12:60-7.

25. Mullner T, Mrkonjic L, Kwasny O, Vecsei V. The use of negative pressure to promote the healing of tissue defects: a clinical trial using the vacuum sealing technique. Br J Plast Surg. 1997;50(3):194-9.
26. Caniano DA, Ruth B, Teich S. Wound management with vacuum-assisted closure: experience in 51 pediatric patients. J Pediatr Surg. 2005;40(1):128-32.
27. Ulusal AE, Sahin MS, Ulusal B, Cakmak G, Tuncay C. Negative pressure wound therapy in patients with diabetic foot. Acta Orthop Traumatol Turc. 2011;45(4):254-60.
28. Zimny S, Schatz H, Pfohl M. Determinants and estimation of healing times in diabetic foot ulcers. J Diabetes Complications. 2002;16(5):327-32.
29. Mendez-Eastman S. Guidelines for using negative pressure wound therapy. Adv Skin Wound Care. 2001; 14(6):314-22.
30. Meloni M, Izzo V, Vainieri E, Giurato L, Ruotolo V, Uccioli L. Management of negative pressure wound therapy in the treatment of diabetic foot ulcers. World J Orthop. 2015;6(4):387-93.

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